


# Impacts of Technology Use on the Workload of Registered Nurses: A Scoping Review

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## Abstract

**Introduction:** Technology is an integral part of healthcare. With the rapid development of technological innovations that inform and support nurses, it is important to assess how these technologies may affect their workload particularly in rural contexts, where the workforce and supports may be limited. **Methods:** This literature review guided by Arksey and O'Malley's scoping review framework describes the breadth of technologies which impact on nurses' workload. Five databases (PubMed, CINAHL, PsycInfo, Web of Science, Business Source Complete) were searched. Thirty-five articles met the inclusion criteria. A data matrix was used to organize the findings. **Findings:** The technology interventions described in the articles covered diverse topics including: Cognitive care technologies; Healthcare providers' technologies; Communication technologies; E-learning technologies; and Assistive technologies and were categorized as: Digital Information Solutions; Digital Education; Mobile Applications; Virtual Communication; Assistive Devices; and Disease diagnoses groups based on the common features. **Conclusion:** Technology can play an important role to support nurses working in rural areas, however, not all technologies have the same impact. While some technologies showed evidence to positively impact nursing workload, this was not universal. Technology solutions should be considered on a contextual basis and thought should be given when selecting technologies to support nursing workload.

## Keywords

Scoping review, rural, technology, nurses

## Introduction

The use of technology has become interwoven into the daily lives of many persons,<sup>1</sup> from the use of smartphones and computers to accessing of the Internet and social media platforms.<sup>2,3</sup> The World Health Organization estimates that more than one billion persons require support from assistive technologies, however access to and use of technologies remain fragmented especially for persons living in rural and northern communities.<sup>4</sup>

Use of technology can be important for healthcare providers to enhance the health, quality of life, and well-being of patients. Not only can the presence of technology in health systems increase the quality of treatments and services provided for patients, but the proper use of

technological equipment can also support a safe and highly efficient work environment for health care professionals.<sup>5</sup> Yet, the implementation of health information technologies in underserved rural areas has been limited so far, in part due

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to the lack of funding and trained staff, as well as insufficient health information technology infrastructures.<sup>6</sup>

When considering the integration of technology, barriers including staff shortage, fear of frequent breakdowns due to vulnerable infrastructures, and a potential increase in workload can be important factors affecting healthcare workers' abilities to leverage technologies.<sup>6-8</sup> Further, for those working in rural areas, rural people's healthcare demands are typically higher, and they have more limited access to health services, technologies, and specialists.<sup>9</sup>

Technology use across healthcare settings has impacted all aspects of nursing practice, including nurses' workload. There is a need to better understand how the use of technology affects nursing workload, especially in rural areas where chronic shortages of health human resources are known to add additional burden.<sup>10-12</sup> Therefore, this literature review, sought to answer the following research question: How can nurses use technologies to reduce workload in rural settings? The diversity of technology in the field of health is enormous, therefore, the focus of this review was to describe the breadth of technologies that impact on nurses' workload and to better understand the existing technologies in the field of health specific to rural communities.

## Methods

This scoping review, guided by Arksey and O'Malley<sup>1</sup> framework, sought to describe the breadth of evidence of the effects of different technologies on nurses' workload in rural areas and followed the five steps including 1) identifying the research question, 2) identifying relevant studies, 3) study selection, 4) charting the data, and 5) collecting, summarizing, and reporting the results. This systematic approach to the review helped to identify a comprehensive range of data, identify gaps in the existing literature, review the studies conducted in this field, and acquire the knowledge to better understand how nurses use technologies to reduce workload in rural settings.

To identify the research question (Step 1), the key words were determined according to population, intervention, context, and effect/outcome. (See [Table 1](#)). The guiding research question was "What is known about how nurses use of technology in rural communities affects their workload".

Relevant studies were identified (Step 2) by using clearly defined inclusion and exclusion criteria ([Table 2](#)). Data from rural settings, where population of residents is under 10,000,<sup>13</sup> was one of the inclusion criteria. Articles published

prior to 2000 were excluded from the literature review to ensure that only up-to-date sources were included. Having up-to-date articles and considering the rapid advancement of technology in the last decade were the reasons for using the above-mentioned criterion.

Study selection (Step 3) was undertaken by systematically searching five databases including: PsycInfo, PubMed, CINAHL, Web of Science, and Business Source Complete (See [supplementary file](#) for database specific search strategies). Database-specific subject headings were chosen for each of the main topics conceptualized where appropriate. In addition to the abstract's title/keyword, topic-specific headings were included in the search. The narrative search strategy description of PubMed, CINAHL, PsycInfo, Web of Science, and Business Source Complete are shown in [Supplementary File](#) which provides a step-by-step description of heading searches and the number of retrieved articles. The number of retrieved articles by the databases is shown in [Figure 1](#).

The researcher used a spreadsheet to organize the extracted data matrix using Excel (Step 4). The data matrix included the headings authors' name, publication date, article's title, the country in which the study was conducted, journal's name, research methodology, analysis, measure used to assess the workload, study objectives, main study findings, population/target, sample size, response rate, sex/gender, intervention, length of intervention, type of technology, strength/efficiency of the technology, barriers of technology use, nurses challenges, rural areas challenges, does the technology decrease nurses workload, how does technology affect nurses, how does technology affect patients, existing knowledge, study limitations and gaps, study strengths, and factors for technology acceptance.

The total number of the retrieved articles was 113 and the number of duplicate articles was 14 ([Figure 1](#)), (Step 5). Thirty-five articles were included in this literature review and the results were generated in the following sections ([Supplementary Appendix Table SA](#)). Data were summarized from the data matrix and were organized thematically. Key findings are now described.

## Findings

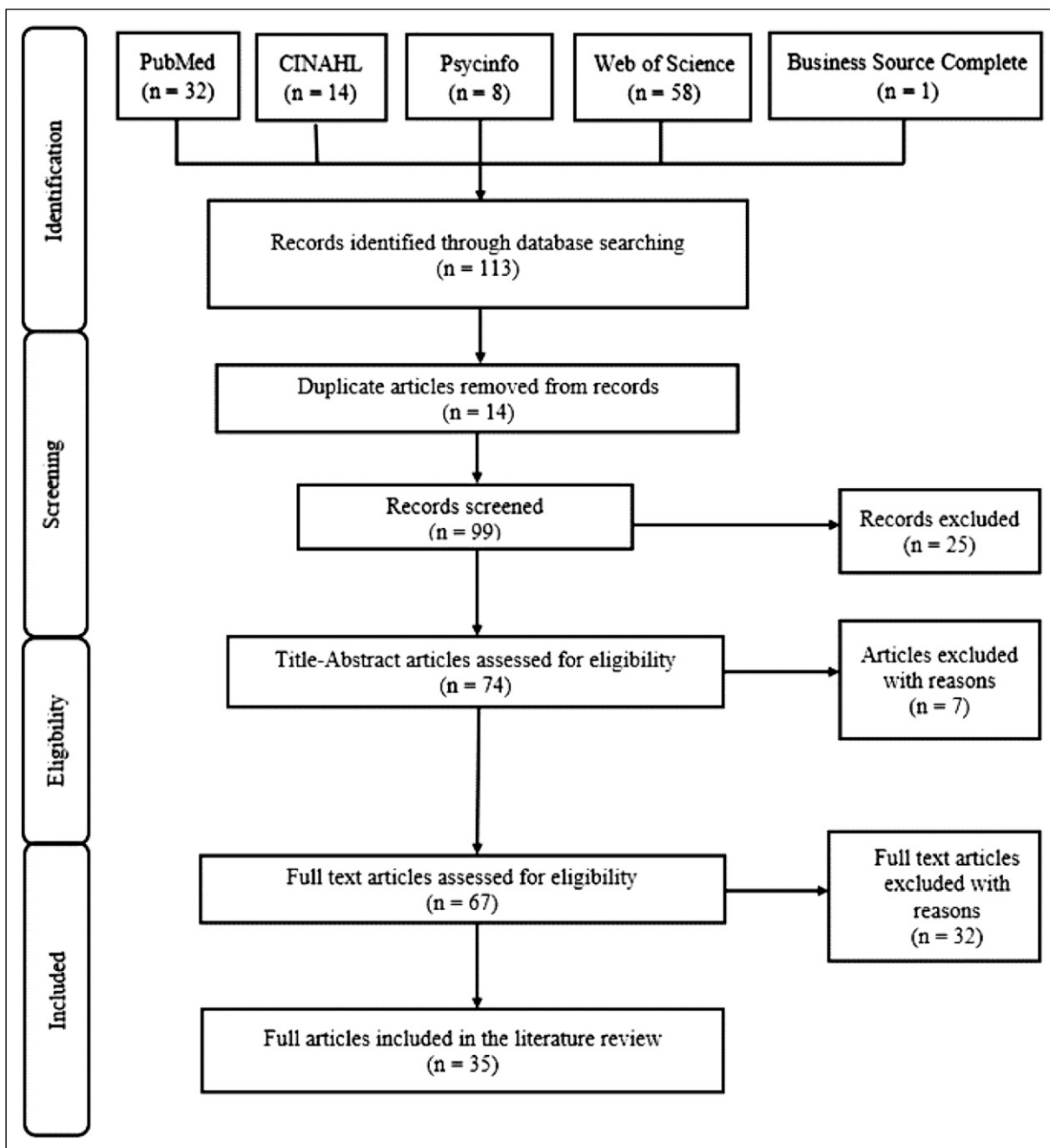
The retrieved articles were published between 2000 and 2020. There was a relatively upward trend in the publication of articles related to the implication of technology in the healthcare industry. The number of studies

**Table 1.** Population, intervention, and effect brainstorming for different keywords selected for all databases.

Theme	Nurse (Population)	Technology (Intervention)	Rural community (Context)	Workload (Effect/Outcome)
	Nurse staffing	Medical automation	Rural region Rural area	Helping behavior Productivity
	Primary care provider	Health care technology	Rural population	Increased performance

**Table 2.** Inclusion and exclusion criteria for article selection.

Inclusion	Exclusion
<ul style="list-style-type: none"> <li>• Nurse</li> <li>• Rural community</li> <li>• Medical technologies as an intervention</li> <li>• Nurses' work quality improvement</li> <li>• Nurses' increased performance</li> <li>• Non-peer studies</li> </ul>	<ul style="list-style-type: none"> <li>• Non- English articles</li> <li>• Published prior to 2000</li> </ul>



**Figure 1.** Process to select articles including PubMed, CINAHL, PsycInfo, Web of Science, and Business source Complete (N = 35): 12 January 2021.

that were published from 2011 to 2020 (65.7%) was almost twice the number of articles published from 2001 to 2010 (34.2%), thus demonstrating an increase in focus on health related technology. The majority of studies were conducted in the United States ( $n = 13$ ), followed by Australia ( $n = 4$ ), Canada ( $n = 3$ ), and Scotland ( $n = 2$ ). Other countries where the studies were conducted included Guatemala, England, Russia, Uganda, India, Democratic Republic of Congo, Thailand, Afghanistan, Bangladesh, and Ghana with only one article in the present literature review. Even though the focus of the research question was on rural areas, some of the retrieved articles included both rural and urban areas. Twenty-seven articles concentrated specifically on rural areas. In addition, seven articles focused on both rural and urban areas. One article had an unspecified research area, but was elected applicable in rural areas.<sup>14</sup>

The participant populations included in studies were highly diverse. Most studies ( $n = 25$ ) assessed health care provider groups including: 1) registered nurses ( $n = 14$ ), 2) community health nurses ( $n = 9$ ), 3) nursing students ( $n = 8$ ), 4) general practitioners (e.g., family physicians;  $n = 5$ ), 5) licensed practical nurses ( $n = 3$ ) and 6) residents ( $n = 1$ ). The remaining five articles only used the word “nurse” and did not describe the type of nurse in detail. The rest of the articles in the present literature review included a variety of participant groups, in addition to nurses such as managers, regional stakeholders, directors, health specialists and staff, midwives, patients, and parents. The sample sizes ranged from ten<sup>15</sup> to 43,430.<sup>16</sup> 31% of the articles included a sample size between 10 and 20.

Most articles did not specify the difference between sex and gender. Many articles either made no reference to sex, nor gender, when collecting their data or selected only one of the two terms as the target of their study. 11 articles reported on the sex of their participants and two studies included information of the participants’ gender. Females outnumbered males in 12 studies, which was due to the fact that the population studied in most of the articles included nurses, a profession that is comprised of mostly females. None of the studies focused exclusively on a distinct sex or gender. Furthermore, the articles demonstrated a wide range of intervention intervals for different technologies. The length of interventions ranged from 1 week<sup>17</sup> to 5 years.<sup>18</sup> Most articles used qualitative ( $n = 15$ ) or quantitative ( $n = 12$ ) methodologies. More than 90% of the quantitative articles used self-report measures for the nurses’ workload while some used observation and database metrics. A common feature was the use of Likert or other similar scales (Supplementary Appendix Table SB).

### Interventions

Technology based interventions described in the articles covered a range of topics and were categorized into the

following groups: 1) Digital Information Solutions 2) Digital Education, 3) Mobile Applications, 4) Virtual Communication, 5) Assistive Devices, and 6) Disease diagnoses groups based on their similarities and common features (Table 3). If an intervention included characteristics that could be categorized into more than one group, they were placed into the group closest to their effectiveness, as determined by the primary author.

**Digital Information Solutions.** Digital Information Solutions included Information and Communication Technologies that supported access to information through telecommunication as well as any health system electronic application, such as intra-organizational email, that provided access to patient information technology (e.g., Electronic Health Records with Electronic Prescribing (e-Rx)).<sup>19</sup> Six articles covered Information and Communication Technologies interventions.<sup>5,11,14,20-22</sup> Effective use of the existing resources and designing new practical methods for nurses were the innovative solutions resulting from Digital Information Solutions.<sup>11</sup> In low-resource areas, Digital Information Solutions can be an adequate tool to improve health care.<sup>20</sup> In this category, half of the studies described a positive effect to decrease nursing workload<sup>5,20,21</sup> while 33% described an increase in nursing workload.<sup>5,14</sup>

Electronic information is one type of Digital Information Solution reported in three articles.<sup>11,20,22</sup> Electronic information technologies were fundamental infrastructures of work activities in the healthcare sector and were seen to facilitate clients/patients’ communication with the medical staff, provide healthcare system’s workload allocation, offer cost estimation, reduce additional costs, offer clinical care and diagnostic tests, and accelerate the communication between service providers and financial resource management.<sup>20,22</sup> Arakawa et al.<sup>20</sup> undertook a mixed method approach to evaluate the usability of electronic information systems for nurses in rural areas, and demonstrated that collecting patient information in electronic systems was more efficient than writing the information manually on paper. Finding Patients’ information in electronic systems was quicker and easier than finding their records in multiple binders.<sup>20</sup> Electronic information systems were found to register more detailed description of the patient and their medical problem.<sup>22</sup> Although in some cases entering patients’ data in the system was a time-consuming task, in most cases using this intervention saved nurses time and increased their communication quality with patients; therefore, Digital Information Solutions led to decrease nurses’ workload.<sup>11,20,22</sup>

Electronic Health Records (EHRs), another type of Digital Information Solution, reported in two articles,<sup>5,21</sup> were used to enter patients’ information and records into electronic clinical systems. Two articles described EHRs with e-Rx interventions that involved sending a

**Table 3.** Interventions' categories studied in the literature review and their types.

Intervention type	Interventions' names
Digital information solutions	<ul style="list-style-type: none"> <li>• Information Technology<sup>14</sup></li> <li>• Electronic health records (EHRs) with electronic prescribing (e-Rx)<sup>5,21</sup></li> <li>• Information and communication technology (ICT)<sup>20-22</sup></li> </ul>
Digital education	<ul style="list-style-type: none"> <li>• Videoconferencing/Videoconsulting<sup>26</sup></li> <li>• Videoconferencing<sup>25</sup></li> <li>• Telemedicine<sup>28</sup></li> <li>• Direct streaming Technology<sup>12</sup></li> <li>• IDEATEL (informatics for diabetes education and Telemedicine)<sup>18</sup></li> <li>• Vidy Platform<sup>24</sup></li> <li>• CBTI (cognitive behavioral therapy for Insomnia)<sup>27</sup></li> </ul>
Mobile applications	<ul style="list-style-type: none"> <li>• Telephone<sup>29,30</sup></li> <li>• Teledoc<sup>32</sup></li> <li>• ImTeCHO<sup>40</sup></li> <li>• Mobile phones<sup>31</sup></li> </ul>
Virtual communication	<ul style="list-style-type: none"> <li>• Electronic clinical decision support systems (eCDSSs)<sup>35</sup></li> <li>• Teleconsultation<sup>17</sup></li> <li>• E-communication<sup>10</sup></li> <li>• Health video library (HVL)<sup>34</sup></li> </ul>
Assistive devices	<ul style="list-style-type: none"> <li>• Care Coordination/Home telehealth (CCHT)<sup>16</sup></li> <li>• Personal digital assistants (PDAs)<sup>36</sup></li> <li>• Teleassistance service in wound care (TASP)<sup>37</sup></li> </ul>
Disease diagnoses	<ul style="list-style-type: none"> <li>• Automated medical Examinations (ACE)<sup>38</sup></li> </ul>

prescription directly from the medical center to the pharmacy.<sup>5,21</sup> The nurses in rural medical centers were responsible for sending the prescriptions to pharmacies, rather than the patient.<sup>5,21</sup> Higher efficiency, full access to drug lists, accessibility of information, access to organized and comprehensive information, drug interaction alerts, decrease in transcription errors, communication with service providers, easier refill process, and the efficiency of workflow were some of the advantages of using EHRs with e-Rx in rural areas.<sup>5,21</sup> The effectiveness of EHRs with e-Rx were noted to save time for nurses by sending information through the Internet, supporting them to keep up to date, and streamlining their workflow consequently reducing nurses' workload.<sup>21</sup>

**Digital Education.** Digital Education, including digital electronic tools and media, enhanced learning opportunities<sup>23</sup> for healthcare workers and for patients (e.g., videoconferencing, video consulting, telemedicine, direct streaming technology). Nurses working in remote or rural areas may not have the same access as in urban areas due to long distances and lack of facilities<sup>24</sup> therefore access to Digital Education improved nurses' access to educational resources and knowledge.<sup>24,25</sup> Application and implementation of Digital Education in remote or rural areas may increase the retention and recruitment of nurses in these regions.<sup>12,24,26</sup> Gum<sup>12</sup> conducted a study demonstrating that access to Digital Education resources could reduce professional isolation and increase retention and recruitment in

remote and rural areas. Information transfer and Digital Education can be expensive.<sup>26</sup> Lack of adequate training and increased workload of nurses were found to be barriers to using this technology.<sup>12,26</sup> 57 percent of technologies mentioned in this category corroborated that access to Digital Education technology decreased nurses' workload,<sup>18,24,25,27,28</sup> while 29% increased it.<sup>12,26,28</sup> Nurses working in rural areas believed that lack of training, technology support, and technology resources would cause an increase in their workload.<sup>12,26</sup> Videoconferencing/video consulting was helpful for providing online training services for healthcare workers including nurses.<sup>26</sup> Implementing e-health technologies had some advantages including clinical usefulness (76%), functioning of equipment (74%), and ease of equipment use (74%) as well as disadvantages included lack of suitable training (55%), costly equipment (54%), and increase in general practitioners/nurses' workload (43%).<sup>26</sup> The use of videoconferencing enhanced the efficiency of patient monitoring at home. In rural areas, home healthcare programs can save time and prevent the severity of illness in patients.<sup>26</sup> Therefore, videoconferencing was viewed to decrease the workload of nurses in rural areas.<sup>25</sup> Telemedicine platforms may be used for Digital Education in rural areas to enhance access to self-directed learning for nurses.<sup>28</sup>

**Mobile Applications.** The World Health Organization (WHO) defined Mobile Applications as "medical and public health practice supported by mobile devices, such as mobile

phones, patient monitoring devices, personal digital assistants, and other wireless devices” World Health Organization (2023) Mobile Applications interventions include follow-up care provided by doctors, nurses, and medical staff, patients’ follow-up visits to the medical center to check their test results, e-prescription of the medications, determination of checkup time, and other tasks done via telecommunication. In this category which includes computer programs, mobile phones, and medical or health-related websites, 66% of the interventions were found to decrease the workload of nurses, while 33% increased the workload.

One of the Mobile Applications category types includes using the telephone. Keeping telephone communication with patients is one of the key elements in providing primary care; however, there is little information on what causes patients to make phone calls.<sup>29</sup> In this intervention, nurses working in rural areas answered the patients’ phone calls and provided them with appropriate healthcare consultation or referred them to other healthcare providers or to the emergency department. The results showed an increase in self-care and a decrease in self-referrals to emergency departments in rural areas, which helped reduce the workload of nurses.<sup>30</sup> In contrast, Townsend et al.<sup>29</sup> discovered that calling patients or answering their phone calls would increase the workload of nurses in addition to making non-clinical office calls, asking nurse practitioners to change an appointment time, and requiring facilities to increase nurses’ workload. Nonetheless, this technology reduced the number of visits to medical centers and increased the provision of clinical services.<sup>29</sup> Further, it was established that mobile phones accelerated the process of providing healthcare services to those who needed help. Using the telephone decreased the number of non-urgent visits to healthcare facilities, but it also increased the number of phone calls to these facilities. Therefore, some studies on this subject showed an increase in nurses’ workload while others noted a decrease in nursing workload in rural areas.<sup>29-31</sup>

Another Mobile Application was the Teledoc website designed to provide customers with medical services through live video or phone connection.<sup>32</sup> The results showed that different patients experienced different results after seeing a doctor through Teledoc. Due to environmental and technical errors, some diagnoses could not be made by solely using telemedicine or looking at the patient’s medical images.<sup>32</sup> Data obtained from the Teledoc website showed that the number of patients’ visits increased while the number of in-person visits to health centers decreased. Face-to-face reduction resulted in nurses’ workload reduction in health facilities. Nurses believed that implementing this new technology in rural areas may decrease nursing workload by increasing people’s remote access to healthcare services. This technology also showed potential to limit non-urgent visits to healthcare facilities.<sup>32</sup>

**Virtual Communication.** Virtual Communication is defined as “the communication which uses electronic media to transmit the information or message using computers, email, telephone, video calling, FAX machine, etc.”.<sup>33</sup> Some types of Virtual Communication are text messages, emails, image sharing, social media messages, Electronic Clinical Decision Support Systems (eCDSSs), teleconsultation, and Health Video Library (HVL). The interventions identified connected nurses to share information and access medical assistance. This category includes technologies that connect nurses or physicians to other physicians, pharmacists, and third persons.<sup>10</sup> Clinical efficiency, cost-effectiveness, and improved treatments are some of the benefits of Virtual Communication technologies. Nurses working in rural areas may contact experienced urban nurses through Virtual Communication technologies to seek advice that may help to decrease their workload.<sup>34</sup> Lack of Virtual Communication training could increase nursing workload.<sup>10</sup> 50% of Virtual Communication technologies showed positive reduction in the workload of nurses<sup>34,35</sup> and 50% described an increase.<sup>10,17</sup>

Teleconsultation is another type of Virtual Communication reported by Opoku et al.<sup>17</sup> In this study, community health nurses (CHNs) were trained to contact a teleconsultation center with their mobile phones whenever they faced any problem.<sup>17</sup> Even though this technology led to faster recovery in patients due to health care quality improvement and increased community health nurses’ knowledge through consultation with other care providers, the workload of teleconsultation team and their work responsibilities increased.<sup>17</sup> The staff workload of teleconsultation increased because they had to answer community health nurses’ questions over the phone in addition to their daily responsibilities. The teleconsultation nurses believed that their salary should have increased due to the increase in their occupational stress and workload. Despite this increase in workload, several community health nurses mentioned that frequent guidance and feedback provided by midwives, physicians, and nurses through telephone consultation increased their knowledge and helped them improve the required skills for treating patients.<sup>17</sup> Technologies that required nurses to assume additional responsibilities within the same amount of time could increase their workload.<sup>10,17</sup>

**Assistive devices.** This category of assistive device interventions included technologies that help health care staff provide better treatments including Care Coordinator/Home telehealth, Personal Digital Assistants, and Teleassistance Service in Wound Care. These assistive devices showed potential to promote patients’ independence, thereby reducing need for nursing supports. In this category, two interventions were found to reduce nursing workload, while one intervention showed an increase.<sup>11,36</sup> Care Coordination/Home Telehealth provided home telehealth

support for the aging veteran who suffered from chronic illnesses to facilitate care coordination for the veterans and prevent unnecessary entry to long-term care.<sup>16</sup> This technology increased aging veterans' independence by keeping them at home and reduced the workload of nurses by decreasing hospital admissions.<sup>16</sup> Personal Digital Assistants, created to instantly provide nurses with reliable information, helped nursing students by providing the required information rapidly from multiple sources, such as drug references, practical manuals, and physiology and anatomy.<sup>36</sup> Nurses were found to employ this technology as a clinical reference for laboratory quantities and regular nursing procedures. Personal Digital Assistants subsequently reduced nursing workload by accelerating timely access to important information.<sup>36</sup> Teleassistance Service in Wound Care is an audio-visual communication system that uses wireless technology to transmit electronic audio and video synchronously and asynchronously.<sup>37</sup> In this procedure, the nurse records the patient's wound by using a mobile application so that it may be viewed by a specialist nurse in another medical center. Gagnon et al.<sup>37</sup>'s case study found that nurses spent a lot of time on ancillary issues (e.g., preparing digital and written reports, collecting additional patient information) and therefore the technology increased their workload.<sup>37</sup>

**Disease diagnostic technologies.** Technologies such as Automated Medical Examination (AME) devices support earlier diagnosis and can also enhance accuracy and timeliness of the diagnosis. This lead to faster patient access to care and recovery as well as a reduced error rate thereby resulting in a decrease in nursing workload.<sup>38</sup> Evseeva et al.<sup>38</sup> examined the use of an AME for pediatric care and described a range of advantages including: timely disease diagnosis in children and adolescents, standard monitoring of children's health, monitoring healthcare activities in medical institutions, appropriate and rational allocation of healthcare, and proper or efficient development of healthcare system structure. By providing early and accurate diagnosis, this system resulted in a reduction in medical staff's workload.<sup>38</sup>

**Barriers and facilitators to technology use by nurses.** Each article included in this review identified one or more barriers and/or facilitators to technology use by nurses in rural areas. Teaching or explaining the intended technology to the target population is one of the most important and frequently reported facilitators for the implementation of technology and technology use in nursing groups. 40% of the articles found that providing proper education and upgrading the knowledge of nurses and the target population were fundamental facilitators for the technology use by nurses.<sup>5,11,14,16-18,22,24,26,29,30,34,37,39,40</sup> Mills et al.<sup>22</sup> highlighted proper training as a facilitator of computer use by

nurses especially in rural areas where training opportunities are more scarce than in urban areas. To reduce workload efforts, nurses must receive sufficient training to use the technology as to limit the amount of additional time necessary for self-learning.<sup>22</sup>

Several factors should be considered prior to technology implementation, including degree of technology acceptance by an organization, resource availability, technology experience, telecommunications capability, and technology acceptance by patients and nurses. Addressing these barriers is important because it improves health delivery by nurses. Ward et al.<sup>14</sup> found that lack of technology acceptance by organizations and nurses is a barrier to the implementation of technology. Some technologies are designed to perform specific nursing tasks, such as IV drip monitoring, and can be highly beneficial and efficient to reduce nursing workload. Mensah et al.<sup>35</sup> found that inadequate technical support was another barrier that should be considered. Lack of technical support was identified as a significant barrier and if nurses faced a problem while using technology and were unable to get help, their workload may increase because they themselves have to solve the issue or spend time looking for support which may take away from time spent on other nursing activities. This barrier is especially challenging in rural areas, where information technology services and supports are not as frequently found compared to urban areas.<sup>35</sup>

**Rural context.** Many articles highlighted challenges due to nursing and healthcare workforce shortages which were amplified in rural and remote areas.<sup>12,15,17,26,34,35,38,40-43</sup> Lack of staff in rural areas has a direct impact on the increase of nurses' workload in these areas because the ratio of patients to nurses may be higher resulting in nurses in rural areas having to care for more patients.<sup>25,26,35,40</sup> Lack of healthcare resources and geographical isolation may limit patients in rural areas, particularly the older adults, to adequately benefit from home healthcare technologies. As a result, compared to those who live in an urban center, patients in rural areas may disproportionately experience inadequate access to health technologies. For example, Evseeva et al.<sup>38</sup> noted that a lack of health information technologies in rural and remote areas can increase nurses' workload because they do not have access to some resources that could make health delivery easier. Terry et al.<sup>42</sup> highlighted geographical location as a challenge in providing care to rural residents. In some cases, nurses had to travel a long distance to deliver healthcare to people living in remote and isolated areas because the residents did not have access to healthcare technologies. Long trips increased nurses' workload in rural areas.<sup>42</sup>

Resource limitations, including lack of access to the most current up-to-date technologies, lack of facilities, and limited infrastructure can be especially challenging for

nurses in rural areas. This is compounded by the nurse shortage in rural, remote, and underserved areas and increases the workload of the nurses. Brambel et al.<sup>21</sup> demonstrated that insufficient access to financial resources is a significant challenge in rural and remote areas because it may decrease nurses and patients access to modern health technologies. Limited allocation of economic resources to these areas has a negative effect on both nurses' salary and available facilities, such as health care centers.<sup>35</sup> For most of the technologies examined in the articles, lack of high-speed Internet access was a major challenge in underserved areas.<sup>27</sup> The information technology infrastructure in rural areas is often weak or inadequate.<sup>35</sup> Accordingly, rural areas may have little access to healthcare services and electronic communication between patients and healthcare providers.<sup>35,38</sup> The mentioned factors increase the workload of nurses in rural areas because they cannot communicate and consult with expert nurses and doctors. Also, having limited access to the high-speed Internet may impede health delivery and accessing information.<sup>35,41</sup>

## Discussion

This review examined the effects of technologies on nurses' workload in rural communities. An analysis of the findings from the included 35 articles demonstrated that the most efficient technologies that help decrease the workload of nurses are those that reduce the number of unnecessary visits of patients to hospitals and medical centers. Common and minor cases can be treated through smartphone applications, live video, and telephone. This kind of technology increases rural patients' access to doctors and nurses.<sup>32</sup> Surprisingly, it was observed that most of the phone calls made to nurses were for non-clinical requests.<sup>29</sup> In addition, nurses believed technologies that save their time have a potential to decrease their workload.<sup>5,11,20,21,22,26</sup>

Considering the results, some factors need to be taken into account in order to implement a technology. Of all the factors identified, training and educating healthcare workers play a key role. Therefore, at the initial stage of implementing any technology, it must be ensured that the population using the technology is informed and has sufficient knowledge. According to Dowding,<sup>43</sup> using the most modern and innovative technologies and preparing healthcare workers to benefit from these technologies is one of the basic expectations of employers and consumers of the healthcare industry. Having the required knowledge allows nurses to make the most of technology and reduce their workload. For example, in most cases, the use of mobile applications reduced the workload of nurses by meeting the needs of patients. However due to workload and time limitations in rural areas, nurses may not be able to fully

benefit from formal in-person training programs; therefore, they may benefit from self-learning modules.

Prior to implementation of a new technology, intervention, or healthcare service in remote and rural areas, the service should have sufficient evidence to support its use.<sup>30</sup> For instance, in the case of using mobile technology, Diese et al.<sup>31</sup> found that the motivation for accepting such technology relied upon awareness of sound data collection and analysis. Most participants agreed that if properly trained, they could use mobile phones to collect the intended data appropriately.<sup>17,28,31</sup> Not all healthcare services are suitable for all places and conditions. The telephone intervention proposed by Roberts et al.<sup>30</sup> was unsuitable for the rural and remote areas in Scotland and thus experienced failure.<sup>30</sup> The issues caused telephone intervention failure in rural and remote areas were "the rigidity of the nurse triage model, the need to understand variation of health service delivery, and the importance of using local, professional knowledge".<sup>30</sup> As mentioned earlier, before implementing any technology, it must be ensured that the technology is tailored to and useable in a particular setting.<sup>14</sup> Checking the appropriateness and applicability of the technology before implementation will lead to a better result of their use, including the potential to reduce the workload of nurses.

One of the most widely used technologies in the healthcare industry are Digital Information Solutions. A review of the literature highlighted that varied perspectives exist with respect to adoption and use of this technology. Entering patients' data or information into electronic systems was shown to increase the workload of nurses.<sup>5</sup> One of the challenges of Digital Information Solutions is its initiators or designers who may have limited knowledge about healthcare or medical treatments.<sup>44</sup> According to Abbott et al.,<sup>5</sup> even though most nurses were familiar with using EHRs correctly, they had trouble performing certain tasks such as sending e-Rx. These problems, which increase the workload of nurses, may occur due to insufficient experience or lack of knowledge in applying this technology. Therefore, Campbell and McDowell<sup>45</sup> stated that EHRs would be useful in the healthcare setting if the medical staff and the users of this technology know how to use it correctly.

Around 80% of nurses believed that using email would increase their workload.<sup>46</sup> Nurses found that documentation by a computerized system was time-consuming. Contrary to the above-mentioned findings, Moody et al.<sup>47</sup> concluded that 36% of nurses consider EHRs a positive technology and believe that it will reduce their workload. Adapting the performance of nurses to this technology and training them to use computers and electronic systems will enhance the absorption of these technologies and ultimately increase the efficiency of the work environment.<sup>20</sup> Database systems help to improve the efficiency of information management and the quality of nursing and community health by



standardizing a format for recording data in rural areas.<sup>20</sup> Accordingly, implementing this technology can reduce nurses' workload.

The second most mentioned intervention described in the results section was Virtual Communication. Virtual Communication technology has several advantages including: saving patients' time and money, reducing patient referrals, saving nurses' time, and improving healthcare.<sup>17,48</sup> Patients' frequent use of Virtual Communication technology has been reported in several studies.<sup>49-52</sup> Frequent use of Virtual Communication by patients reduces their non-urgent admission to healthcare facilities and reduces nurses' workload and time.<sup>51,52</sup> Moreover, several articles have shown that rural patients are more willing to communicate with physicians and clinic staff through Virtual Communication which can save doctors and healthcare providers time and decrease their workload.<sup>53,54</sup> Nonetheless, the disadvantages of this technology include delays in answering phone calls, medical staff's insufficient knowledge of the technology, and inappropriate and erroneous information transmitted over the phone.<sup>17</sup> Sometimes, nurses' limited or inaccurate information about a specific technology can increase their workload.<sup>17</sup> Another disadvantage of this technology is the security of patients' health information, which has been a cause of great concern to patients and healthcare systems. Moreover, after implementing Virtual Communication technology, healthcare staff expressed their concern about the increase in workload.<sup>17</sup> Entering patient information into the system can be stressful because any incorrect information may cause unintended consequences such as inaccurate medical records.

As nursing has historically been a female-dominated profession,<sup>55</sup> there is a lack of males represented in the current research evidence. No articles focused on sex or gender-based differences in nurses' perspectives or experiences with technology. Future, it appeared that most articles concentrated on the efficiency of various technologies and their positive or negative impacts on healthcare personnel and/or patients without taking into consideration the roles of sex and gender of the patient. Therefore, further research may consider examining whether there are any differences in how technology influences workload. With the rapid development and iterations of technology, it remains an important and pressing issue to continue to assess as technology continues to become more integrated into nursing practice across the care continuum and across the globe.

## Conclusion

Use of technologies can effect nursing workload either by increasing it or reducing it. The effect on nursing workload may depend on multiple factors, such as institutions' technology acceptance, nurses' technology acceptance, and nurses' knowledge of using the technology. The workload of

nurses working in rural areas was different from in urban areas, which was due to the low number of nurses in remote places and unequal distribution of work in these regions. While the majority of articles indicated the positive impact of the technologies used by nurses, there remains a lack of consensus across varying technology types warranting further research.

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## Supplemental Material

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